

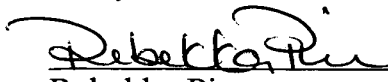
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CERTIFICATION

I, the below named translator, hereby declare that: my name and post office address are as stated below; that I am knowledgeable in the English and German languages, and that I believe that the attached text is a true and complete translation of PCT/DE2005/000444, filed with the German Patent Office on March 8, 2005.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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1 Description

2  
3 Drive device with an input shaft and an output shaft  
4 particularly for driving a contact piece of an electrical  
5 switching device

6  
7 The invention relates to a drive device with a rotatable input  
8 shaft and a rotatable output shaft.

9  
10 US patent US 4,240,300 has disclosed, for example, a drive  
11 device in which helical springs acting as energy stores are  
12 compressed by means of a rotatable input shaft. When the drive  
13 device is actuated, the energy stored in the compressed  
14 helical springs is transferred to an output shaft within a  
15 very short time interval. The output shaft serves to transfer  
16 a movement to a movable contact piece of a circuit breaker to  
17 switch an electrical circuit. In the process, the helical  
18 springs are tensioned by means of a slowly running drive  
19 device. However, the energy stored in the tensioned helical  
20 springs is released suddenly. A wide variety of shafts, gear  
21 wheels, levers and rods, which have to be moved, are necessary  
22 in order to produce this movement sequence. Owing to the rapid  
23 movement, the individual elements of the drive device need to  
24 have large dimensions and constitute a complex arrangement.

25  
26 The invention is based on the object of designing a drive  
27 device of the kind mentioned in the introduction with a  
28 simplified construction.

29  
30 In a drive device of the kind mentioned in the introduction,  
31 the object is achieved according to the invention in that the  
32 input shaft and the output shaft are connected to one another  
33 by means of a magnetic coupling having at least two magnet  
34 pairs, wherein a first blocking device limits the ability of  
35 the output shaft to rotate in a first direction of rotation,  
36 and, after the first blocking device has become effective,  
37 owing to magnetic forces emanating from the magnetic coupling

1 a movement of the output shaft takes place in a second  
2 direction of rotation opposite to the first.

3  
4 A magnetic coupling is disclosed, for example, in the KTR  
5 publication "Dauermagnetische Synchronkupplung" [Permanent  
6 magnet synchronous coupling]. A magnetic coupling allows  
7 torque to be transmitted without contact. Magnetic couplings  
8 of this kind transmit a continuous rotational movement, for  
9 example of a drive motor and to a pump. Because of the  
10 contactless transmission of torque, it is possible to provide  
11 hermetic separation of the input drive-side and output drive-  
12 side. To do this, a so-called split case is arranged between  
13 the coupling elements. By means of the split case, it is  
14 possible to transmit rotational movements through walls where  
15 it is not desirable to make an opening for the purpose of  
16 feeding through a rotatable shaft.

17  
18 The known magnetic coupling transmits the movement of the  
19 input shaft directly to the output shaft. This means that the  
20 transmission of the driving movement takes place almost  
21 without slip.

22  
23 The magnet pairs each have a north and south pole on the  
24 surfaces facing one another so that attractive forces occur  
25 between the magnet pairs. The output shaft and the input shaft  
26 are coupled to one another and movements can be transmitted by  
27 means of these forces. The output shaft is blocked in a first  
28 direction of rotation by means of the first blocking device. A  
29 blocking device of this kind can be designed, for example, in  
30 the form of a stop. The stop forces the associated magnet  
31 pairs to be displaced. As a result of this, the input and  
32 output shafts, which are usually moved in synchronism with one  
33 another, are moved asynchronously with respect to one another.  
34 If the offset of the input shaft and the output shaft with  
35 respect to one another is sufficiently large that the magnet  
36 pair partners associated with one another change owing to the  
37 magnetic forces, the output shaft is moved in a second

1 direction of rotation opposite to the first. This enables a  
2 reversal in the direction of rotation between the input shaft  
3 and the output shaft to be produced easily by means of a  
4 magnetic coupling. As only the magnetic coupling itself is  
5 necessary for this, the use of reversing gears or similar can  
6 be dispensed with. This results in a very compact and light  
7 arrangement.

8  
9 Here, it can be advantageously arranged that the input shaft  
10 is moved and continues to be moved when the output shaft is  
11 blocked.

12  
13 The speed of the reversal of the direction of rotation can be  
14 easily affected by a further movement of the input shaft. An  
15 additional acceleration of the input shaft after the first  
16 blocking device has become effective also causes a rapid  
17 reversal of the direction of movement. It is particularly  
18 advantageous if, at the beginning of the rotational movement  
19 of the input shaft, the output shaft is already prevented by  
20 the blocking device from moving in the first direction of  
21 rotation. This makes it possible for the reversal of the  
22 rotational movement to be initiated immediately.

23  
24 Furthermore, it can be especially advantageously arranged that  
25 the transition to the second direction of rotation of the  
26 output shaft takes place suddenly.

27  
28 By utilizing a sudden movement of the output shaft in the  
29 second direction of rotation, it is possible to use the drive  
30 device for switching devices with high switching speeds, for  
31 example. In switching devices such as high-voltage high-speed  
32 grounding switches, for example, it is necessary to switch  
33 these very quickly in order to prevent the formation of  
34 switching arcs. Previously, therefore, energy storage devices,  
35 for example compression springs or hydraulic storage devices,  
36 have been used to release a high driving energy precisely. A  
37 sudden rotational movement of the output shaft can now be

1 produced by using a drive device with a magnetic coupling  
2 according to the invention. Additional energy storage devices  
3 are not required, as the magnetic forces that can be produced  
4 by the magnetic coupling are utilized. This makes it possible  
5 for a continuous, comparatively slow driving movement to be  
6 converted into a short, fast driven movement.

7  
8 Furthermore, it can be advantageously arranged that a second  
9 blocking device causes a reversal of the movement of the  
10 output shaft from the second to the first direction of  
11 rotation.

12  
13 By providing a second blocking device, it is now possible to  
14 rotate the output shaft backwards and forwards between the  
15 first and the second blocking device. In this way, a certain  
16 angle of rotation of the output shaft can be provided, for  
17 example.

18  
19 This angle of rotation can be 45°, 60°, 72° or 90°, for  
20 example. The position of the blocking devices with respect to  
21 the output shaft must be chosen accordingly.

22  
23 A further object of the invention is to specify a suitable  
24 method for operating a magnetic coupling, which couples an  
25 input shaft and an output shaft to one another.

26  
27 According to the invention, in a method for operating a  
28 magnetic coupling, it is intended that the input shaft be  
29 moved, the output shaft be blocked in a first direction of  
30 rotation, the input shaft be moved further, and the output  
31 shaft be moved suddenly in a second direction of rotation,  
32 which is opposite to the first direction of rotation.

33  
34 As a result of the method according to the invention, it is  
35 possible to convert a continuous rotational movement into a  
36 suddenly acting rotational movement by using a magnetic  
37 coupling. Here, an attempt is first made to use the input

1 shaft to move the output shaft in a first direction of  
2 rotation in which it is blocked. When the input shaft moves  
3 further, the output shaft is rotated in a second direction of  
4 rotation, which is opposite to the first direction of  
5 rotation. In this way, it is possible to use a magnetic  
6 coupling for reversing a rotational movement.

7  
8 Furthermore, it can be advantageously arranged that a drive  
9 device with the characteristics described above be employed to  
10 use the movement of the output shaft for driving a movable  
11 contact piece of an electrical switching device.

12  
13 In high-voltage engineering, i.e. at voltage levels from  
14 10 000 volts, in particular from 70 000 volts, switching  
15 devices are used, whose contact pieces have to be moved  
16 suddenly. Examples of such switching devices are circuit  
17 breakers, high-speed grounding switches and also load  
18 interrupter switches. The contact piece has to be moved from  
19 its off position to the on position or vice versa within very  
20 short periods of time, i.e. within fractions of a second.  
21 Conventional transmissions such as hydraulic transmissions or  
22 mechanical transmissions with toothed elements are subject to  
23 increased wear as a result of the suddenly occurring  
24 movements. The use of a drive device with magnetic coupling  
25 according to the invention allows high driving forces to be  
26 transmitted while only a small amount of mechanical wear takes  
27 place. Furthermore, it has previously been common to provide  
28 complex energy storage devices, such as compression springs or  
29 hydraulic storage devices or compressed air storage devices,  
30 in order to provide large amounts of energy within short  
31 periods of time for moving the contact pieces. The drive  
32 device according to the invention now allows relatively slowly  
33 running continuously acting drives to be used and a sudden  
34 type of movement to be produced at the output shaft. This  
35 means that cost-intensive energy storage devices can be  
36 dispensed with. A further advantage with magnetic couplings  
37 according to the invention is that appropriate split cases can

1 be used, which penetrate the magnetic gap of the coupling and  
2 therefore make it possible for the input-drive and output-  
3 drive side of the drive device to be hermetically separated.  
4 In order to achieve high dielectric strengths, electrical  
5 switching devices in the high-voltage field are often arranged  
6 in gas-tight encapsulated housings, which are filled with an  
7 insulating gas under elevated pressure. By using a so-called  
8 split case, it is now possible to transmit a driving movement  
9 through the wall of an encapsulated housing. As a result of  
10 this, the elaborate gas-tight sealing of shafts fed rotatably  
11 through the wall of the encapsulated housing can be dispensed  
12 with.

13  
14 In the following, the invention is shown schematically in a  
15 drawing and described in more detail with reference to an  
16 exemplary embodiment.

17  
18 In the drawing,

19  
20 figure 1 shows the schematic construction of an input shaft  
21 and an output shaft with a magnetic coupling, and

22  
23 figure 2 shows the sequence involved in a method according to  
24 the invention.

25  
26 Figure 1 shows a drive device with an input shaft 1 and an  
27 output shaft 2. The input shaft 1 and the output shaft 2 are  
28 each rotatably mounted. A rotational movement can be imposed  
29 upon the input shaft 1 by means of a drive lever 3. A blocking  
30 lever 4 is arranged on the output shaft 2. The input shaft 1  
31 and the output shaft 2 are arranged coaxially with respect to  
32 one another so that their faces are opposite to one another. A  
33 magnetic coupling 5 is arranged on their facing ends. The  
34 magnetic coupling 5 has an input drive-side coupling element 6  
35 and an output drive-side coupling element 7. The input drive-  
36 side coupling element 6 is arranged on the input shaft 1. The  
37 output drive-side coupling element 7 is arranged on the output

1 shaft 2. The input drive-side coupling element 6 is designed  
2 as a hollow cylinder. A multiplicity of magnets is arranged  
3 radially on the circumference of the input drive-side coupling  
4 element 6. These magnets are preferably permanent magnets. At  
5 the same time, the radial distribution is chosen in such a way  
6 that north and south poles of the magnets are arranged  
7 alternately radially around the inner sheath surface of the  
8 hollow-cylindrical input drive-side coupling element 6. The  
9 output drive-side coupling element is cylindrical and has a  
10 diameter such that it can be moved into the hollow-cylindrical  
11 input drive-side coupling element 6. The output drive-side  
12 coupling element 7 has north and south poles of magnets each  
13 radially distributed alternately on its outer sheath surface.  
14 At the same time, the radial distribution of the magnets on  
15 the input drive-side coupling element 6 and the output drive-  
16 side coupling element 7 is chosen to be in the form of sectors  
17 in such a way that, when the output drive-side coupling  
18 element 7 is moved into the input drive-side coupling element  
19 6, a multiplicity of magnet pairs is formed which are clearly  
20 associated with one another by means of the magnetic forces.

21  
22 Figure 1 shows the magnetic coupling 5 in a decoupled state.  
23 The two coupling elements 6, 7 must be inserted one into the  
24 other for the magnetic coupling 5 to become effective. The  
25 coupling elements 6, 7 can be designed, for example, in  
26 accordance with the magnetic coupling disclosed in the KTR  
27 publication "Dauermagnetische Synchronkupplung" [Permanent  
28 magnet synchronous coupling].

29  
30 In addition, it is also conceivable for other different  
31 embodiments of magnetic couplings to be used. For example, it  
32 is possible to use coupling elements that to be arranged so as  
33 to face one another in order to achieve a coupling effect, and  
34 else coupling elements that enable an arrangement of the axes  
35 of rotation of the coupling elements other than a coaxial  
36 arrangement. Examples of arrangements of this kind are  
37 parallel axes of rotation (the magnet poles are then each



1 located radially on the external circumference of the coupling  
2 elements) or else axes of rotation that are at an angle to one  
3 another in the manner of a bevel gear.

4  
5 Figure 2 shows a sectional view through the magnetic coupling  
6 5 wherein the input drive-side coupling element 6 encloses the  
7 output drive-side coupling element 7, as a result of which the  
8 respective magnet pairs can exert a force effect on one  
9 another. The coupling of a drive device 8 to the drive lever 3  
10 is shown schematically. The drive device 8 can be an electric  
11 motor drive, for example, in particular an electromagnetic  
12 linear drive. An electrical switching device 9 is also shown  
13 symbolically in figure 2. The electrical switching device 9  
14 has a movable contact piece, which is connected to the  
15 blocking lever 4, shown schematically. The translation of the  
16 driving movement to the switching movement can be adjusted by  
17 changing the lengths of the drive lever 3 as well as the lever  
18 arm on the blocking lever 4. The electrical switching device 9  
19 can in particular be a grounding switch or a high-speed  
20 grounding switch in the field of electrical high-voltage  
21 engineering. A rotational movement of the output shaft 2 in a  
22 first direction of rotation 11 is limited by means of a first  
23 blocking device 10 via the blocking lever 4. The ability of  
24 the output shaft to move in a second direction of rotation 13  
25 is limited by means of a second blocking device 12. The first  
26 blocking device 10 and the second blocking device 12 are  
27 designed in the form of mechanical stops against each of which  
28 the blocking lever 4 strikes alternately. The possible angle  
29 of rotation of the output shaft 2 is limited by the  
30 arrangement of the blocking devices 10, 12.

31  
32 In the interests of simplifying the diagram, only the poles of  
33 the magnet pairs necessary for transmitting the movement are  
34 shown. In the coupling elements 6, 7 shown in figure 2, six  
35 magnet pairs have been evenly distributed radially on the  
36 circumferences. This results in a switching angle of 60°. As a  
37 deviation from this, four magnet pairs, five magnet pairs or

1 eight magnet pairs can also be used, resulting in switching  
2 angles of  $90^\circ$ ,  $72^\circ$  and  $45^\circ$ . A movement sequence of the drive  
3 arrangement shown in figure 2 is described in the following  
4 wherein the movable contact piece of the electrical switch 9  
5 is moved suddenly from an off position "0" into an on position  
6 "1". The drive device 8 moves the drive lever 3 and thus the  
7 input shaft 1 as well as the input drive-side coupling element  
8 6 in the first direction of rotation 11. The blocking lever 4  
9 fixed to the output shaft 2 bears against the first blocking  
10 device 10. Owing to the attractive force effect between the  
11 magnet pairs on the input drive-side coupling element 6 and on  
12 the output drive-side coupling element 7, the blocking lever 4  
13 is pressed against the first blocking device 10. The input  
14 shaft 1 is moved further by means of the drive lever 3. When  
15 half the switching angle has been reached,  $30^\circ$  in the present  
16 example, a transition position of the magnetic coupling 5 is  
17 reached. This means that the magnet pairs are arranged so as  
18 to be displaced with respect to one another by approximately  
19 half of the effective pole faces. If the drive lever 3 is  
20 moved further in the first direction of rotation 11, pole  
21 faces of the same polarity overlap one another to an ever-  
22 increasing extent. Magnets of the same polarity repel one  
23 another. When a critical position is reached, the repelling  
24 forces are sufficiently large that the blocking lever 4 with  
25 the output shaft 2 is moved suddenly in the second direction  
26 of rotation 13. The blocking lever 4 strikes against the  
27 second blocking device 12 in this direction of rotation.

28  
29 During the movement, the blocking lever 4 is initially pressed  
30 against the first blocking device 10 owing to the attractive  
31 magnetic forces of the magnet pairs of unequal polarity. The  
32 repelling forces of pole faces of the same polarity are  
33 utilized during a further phase of the movement of the input  
34 shaft 1.

35  
36 The blocking lever 4 moves back from the second blocking  
37 device 12 to the first blocking device 10 in the same manner.

1 Magnet pairs with different magnet poles lie opposite one  
2 another in the end positions of the blocking lever 4 both when  
3 the blocking lever 4 strikes the first blocking device 10 and  
4 also when the blocking lever 4 bears against the second  
5 blocking device 12, with the result that a stable position of  
6 the output shaft is automatically produced owing to the force  
7 effect of the magnetic coupling.

8  
9 When a split case is used which is placed in the gap between  
10 the input drive-side coupling element 6 and the output drive-  
11 side coupling element 7, the driving movement can also be  
12 transmitted through a closed wall. At the same time, the wall  
13 can be an encapsulated housing of a compressed gas-insulated  
14 switchgear assembly or a compressed gas-insulated switching  
15 device, for example. In this case, the split case is part of  
16 the wall.

17